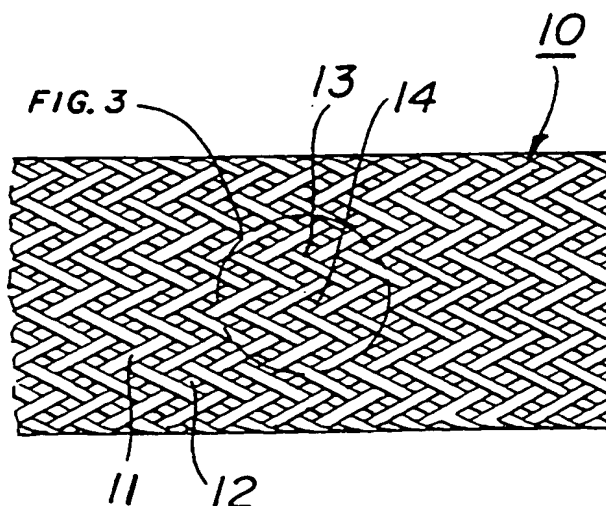




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TRÉATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b>  <b>D04C 1/02, 1/06</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 91/14034</b>  <b>(43) International Publication Date:</b> 19 September 1991 (19.09.91)
<b>(21) International Application Number:</b> PCT/US91/01303 <b>(22) International Filing Date:</b> 28 February 1991 (28.02.91)  <b>(30) Priority data:</b> 492,802                   12 March 1990 (12.03.90)                   US  <b>(71) Applicant:</b> THE BENTLEY-HARRIS MANUFACTURING COMPANY [US/US]; 241 Welsh Pool Road, Lionville, PA 19353 (US).  <b>(72) Inventor:</b> KITE, J., Sellers, III ; 721 Invermess Drive, W. Chester, PA 19380 (US).  <b>(74) Agents:</b> FREE, Albert, L. et al.; Synnestvedt & Lechner, 2600 One Reading Center, 1101 Market Street, Philadelphia, PA 19107 (US).		<b>(81) Designated States:</b> AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), SE (European patent), SU.  <b>Published</b> <i>With international search report.</i>

**(54) Title:** BRAIDED PRODUCT AND METHOD OF MAKING SAME

**(57) Abstract**

An expandable braided product having greatly reduced tendency to splay at its ends when cut is provided by coating the braided product (10) with a thin layer of elastomeric material which provides the desired anti-splaying property, while retaining the expandable characteristic whereby the product expands laterally when compressed longitudinally and when released returns to its original size and shape.

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1                    BRAIDED PRODUCT AND METHOD OF MAKING SAME

Field of the Invention

                  This invention relates to monofilament braided product and to methods for making same. It relates more particularly to braided product made up of monofilaments, typically of a resilient engineered plastic material and typically (but not necessarily) in the form of a tubular sleeve.

Background of the Invention

10                   One known form of braided product is the Expando™ self-fitting protective oversleeve made by Bentley-Harris Manufacturing Co. of Lionville, Pennsylvania. This tubular sleeve is expandable in that, when the ends are pushed toward each other it expands in diameter, and when they are released  
15 it returns to its original shape and size. This enables it to be pulled or pushed over objects of different diameters, including diameters greater than the unstressed or "rest" diameter of the sleeve, and also enables it to accommodate expansion, bending and twisting of hoses or wires which may  
20 run through it. This expandable braided product also exhibits a "spring-back" or "memory" characteristic, whereby it tends to return to its rest diameter when released from longitudinal forces. Such expandable braided sleeving has been widely used, for example to protect, and/or dress,  
25 wiring harnesses and hose assemblies.

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1           One difficulty with the typical braided product of  
the expandable type is that when the braid is cut in an  
ordinary manner, as by scissors, the ends of the braid will  
tend to unravel or splay, the braiding coming apart for a  
5   substantial distance back from the cut ends. This is  
particularly troublesome when an end of a braided sleeve must  
be forced over a large-diameter object, causing the  
monofilaments to splay and therefore no longer provide the  
desired type of tight fit on the smaller-diameter contents of  
10 the tubular covering; in addition such splaying is  
cosmetically very undesirable.

There are currently three principal ways in which  
this problem has been addressed, as follows:

15       (1) Coat the braided product with a continuous  
coating. This eliminates the splaying, but also restricts  
the expandability of the braid and therefore its ability to  
slide over, or wrap around, an object with full conformity to  
a variable cross-section of the object. Such a construction  
also prevents one from "breaking out" a branching wire from  
20 the interior of braided tubing, as is sometimes desirable.

      (2) Heat-set the braided product. Heating the  
completed product will put a slight set into the braid, but  
with even slight mechanical expansion the ends will unbraid  
and splay out again.

25       (3) Cut the braid with a hot knife or wire. With  
most plastic braidings, the sleeve can be cut through with a  
hot knife or wire, thereby fusing the monofilaments to each  
other to prevent the braid from fraying or unraveling.  
However, such end treatment will fix the diameter at that set  
30 by the fusing of the end of the tubular braid, and thereby

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- 1 prevent the braid from expanding readily to receive a large  
object. Further, this method requires use of special hot  
melt devices to provide such cutting of the braid, and  
therefore is not useful for field installations of the sleeve  
5 where no such special tools are available.

Accordingly, it is an object of the present  
invention to provide a new braided product and method of  
making it, which minimize such fraying while retaining the  
natural expansion and contraction characteristics of the  
10 expandable type of braided product.

It is also an object of the invention to provide  
such method and apparatus in which the treatment providing  
the above described advantageous characteristics is readily  
and inexpensively performed, and in which the user can cut  
15 the resultant braided product to the desired length without  
having to use any special cutting or bonding tools.

#### Summary of the Invention

These and other objects of the invention are  
achieved by the provision of a monofilament braided product  
20 in which the braided product is at least partly coated with  
an adherent, preferably elastomeric, material extending from  
at least some over-weave monofilaments to their associated  
underweave monofilaments at their respective cross-overs,  
permitting the monofilaments to pivot with respect to each  
25 other as required to retain the desired expandable  
characteristics, while preventing splaying. The coating is

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- 1 preferably of an elastomeric material, and preferably does not completely cover the openings between the monofilaments.

The coating is preferably applied by passing the braid continuously through a liquid bath containing the  
5 coating material in flowable form, and then solidifying the coating in position on the braided product. The viscosity of the liquid of the coating is such that it provides enough material in the proper places to fix the monofilaments against end splaying, while retaining the ability of the  
10 filaments to pivot with respect to each other, and the consequent ability of the sleeve to expand and shrink in cross-sectional size. If the coating does initially extend across the openings between the monofilaments, it is preferably such as to break upon longitudinal compression of  
15 the braided material, although with a sufficiently compliant elastomeric material this is not always necessary.

In this manner there is provided a braided product and method of making it which prevent splaying of the end of the braid without materially adversely affecting the  
20 expandable characteristics of the braid.

#### Brief Description of Figures

These and other objects of the invention will be understood from a consideration of the following detailed description taken in connection with the accompanying  
25 drawings, in which:

Figure 1 is a side view of a section of expandable tubular product which has been cut by an ordinary pair of

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1 scissors, and mechanically expanded at the cut end, and which exhibits substantial splaying at its end;

Figure 2 is a side view of a section of expandable braided product made in accordance with the invention, cut at  
5 its end with an ordinary pair of scissors and then subjected to a similar expanding procedure.

Figure 3 is an enlarged fragmentary view of the exterior of the braided product of Fig. 2;

Figure 4 is a cross-sectional view taken on lines  
10 4-4 of Figure 3, showing the braided product of the invention after the coating has been formed therein;

Figure 5 is a cross-sectional view taken along lines 5-5 of Fig. 3; and

Figure 6 is a cross-sectional view like Figure 5,  
15 but illustrating the condition in which a break exists in the coating near each cross-over of the braid.

#### Detailed Description of Specific Embodiments

Referring now to the embodiment of the invention shown in the drawings by way of example only, and without  
20 thereby limiting the scope of the invention, Figure 1 shows a section of expanded, braided tubular sleeving 8, constructed in accordance with the prior art and exhibiting undesired splaying of the monofilaments at its end 9. Figure 2 shows a  
length of expandable, braided, tubular sleeving 10 in  
25 accordance with the present embodiment of the invention. It is made up of monofilaments such as 11, 12, 13, 14 in a simple single-strand two-over, two-under braid pattern. Each monofilament in this example is of engineered plastic, for example nylon or polyester, and is substantially rectangular

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1 in cross-section. The monofilaments are covered with an  
adherent elastomeric coating 16. In some cases, particularly  
after expansion and contraction of the braid by pulling and  
pushing of its ends, the coating may contain a break where  
5 one monofilament crosses another, as indicated by the break  
lines such as 20, 21 in Fig. 6.

In this preferred embodiment of the invention the  
coating does not decrease substantially the areas of the  
openings such as 30, 31 between the monofilaments, so that  
10 space remains for the filaments to pivot at the cross-overs,  
one with respect to its adjacent neighbor, during expansion  
and contraction of the sleeve, according to the usual  
characteristic of such expandable braids. The elastomeric  
coating tends to fix the positions of the cross-overs, but  
15 being elastomeric, it permits the necessary pivoting of the  
monofilaments with respect to each other. This fixing action  
of the elastomeric material prevents the ends from splaying,  
as is important for the reasons pointed out above. The  
retention of the openings such as 30, 31 also permits a wire  
20 or the like to be extracted and passed outwardly from the  
sleeve if so desired.

While there may be a variety of methods by which  
the coating may be applied, it is preferred to accomplish it  
by passing a continuous sleeve of the braided material  
25 through a bath of the coating material and then drying it in  
an oven.

One presently-preferred example of the improved  
braided product and of a method for making it, is as follows:

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1           A continuous, expandable braided tube of about  
9.5x10<sup>-3</sup> meters rest diameter is made in conventional manner  
from 48 monofilaments of 100 denier nylon, each monofilament  
about 30 mils wide and about 10 mils in thickness; the  
5   braided tubing is typically coiled on a spool in long  
lengths, e.g. 609.6 meters lengths. The tubing from the  
spool is then run lengthwise downward into and through a bath  
of the coating material, continuing upwardly therefrom  
through a hot-air oven typically operating at about 150°C.

10           The liquid coating material may be resorcinol  
formaldehyde, with a viscosity of 15,000 centipoises or less  
so that it will coat the monofilaments in the braid without  
closing the openings between them. Preferably the tubing is  
subjected to stretching while passing through the bath, and  
15   until drying of the coating is complete.

The resultant braided tubing can be cut to length  
with ordinary scissors, and will then exhibit minimal  
tendency toward splaying. Nevertheless, when longitudinally  
compressed it will increase its diameter and when stretched  
20   it will regain its original diameter, and it will also  
exhibit memory in that, when unstressed, it tends to return  
to the diameter and length it had before compression.

In general, the invention is applicable to a wide  
variety of sizes, shapes and materials of braids and of  
25   monofilaments, including monofilaments of round cross-  
section; it is also of wide applicability with respect to the  
number of monofilaments in the braid. While many important

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1 applications of the invention involve a tubular braid, the  
invention is also useful in making flat, mat-like expandable  
braid products. Also, while the coating materials is  
preferably elastomeric, at least some of the advantages of  
5 the invention may be realized by using a non-elastomeric  
material for the coating which does not bond the filaments  
rigidly together, but instead fractures upon compression and/  
or stretching of the braid, leaving low walls of coating  
material on each side of each monofilament at each cross-over  
10 to provide a positioning channel, or at least a high-friction  
surface, which resists the type of displacement of the  
monofilaments which occurs during splaying. A similar effect  
exists in some cases when an elastomeric material is used  
which fractures during stretching and/or compression. Other  
15 coating procedures may also be used, so long as they do not  
result in such a thick, pervasive coating that the  
monofilaments cannot pivot, each with respect to its  
neighbor, as is required to exhibit the desired expandable  
characteristic.

20 While the invention has been described with  
particular reference to specific embodiments thereof in the  
interest of complete definiteness, it may be embodied in a  
variety of forms diverse from those specifically shown and  
described, without departing from the spirit and scope of the  
25 invention.

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1

WHAT IS CLAIMED IS:

1. An expandable monofilament braided product, comprising a plurality of braided monofilaments and a coating of adherent solid material on said filaments holding said  
5 filaments in their proper relative positions to prevent splaying of the ends of said braid while permitting them to pivot with respect to each other at each of their cross-overs so as to retain the expandable characteristics of said braided product.

10

2. The braided product of claim 1, wherein said adherent solid material is elastomeric.

3. The braided product of claim 2, wherein said coating leaves the openings between said monofilaments substantially free of said coating.

15

4. The braided product of claim 2, wherein said material is selected from the group consisting of resorcinol formaldehyde and acrylic latex.

5. The braided product of claim 1, wherein said monofilaments are of engineered plastic material.

20

6. The braided product of claim 5, wherein said monofilaments are of nylon or polyester.

7. The braided product of claim 1, wherein said coating extends over substantially all of the exposed surfaces of said monofilaments throughout the length of said

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1 braided product.

8. The braided product of claim 1, wherein said coating is from about 1 to about 20 mils in thickness.

5 9. The method of treating a monofilament expandable braided product to reduce its tendency to splay at its ends while retaining its expandable properties, comprising:

15 forming a solid coating of adherent solid material on said monofilaments of said braid to hold them in their proper relative positions and thereby minimize the tendency toward splaying at the ends of said braid, said coating permitting said monofilaments to pivot with respect to each other at their cross-overs so as to retain the expandable characteristics of said braided product.

20 10. The method claim 9, wherein said material is elastomeric.

11. The method of claim 10, wherein said material is selected from the group consisting of resorcinal formaldehyde and acrylic latex.

25 12. The method of claim 9, wherein said coating is from about 1 to about 20 mils in thickness.

30 13. The method of claim 9, wherein said forming of said coating comprises passing said braid through a bath of said material in its flowable form, and thereafter allowing said material to solidify on said braid.

-11-

1           14. The method of claim 13, wherein said material  
of flowable form has a viscosity not substantially greater  
than 15,000 centipoises.

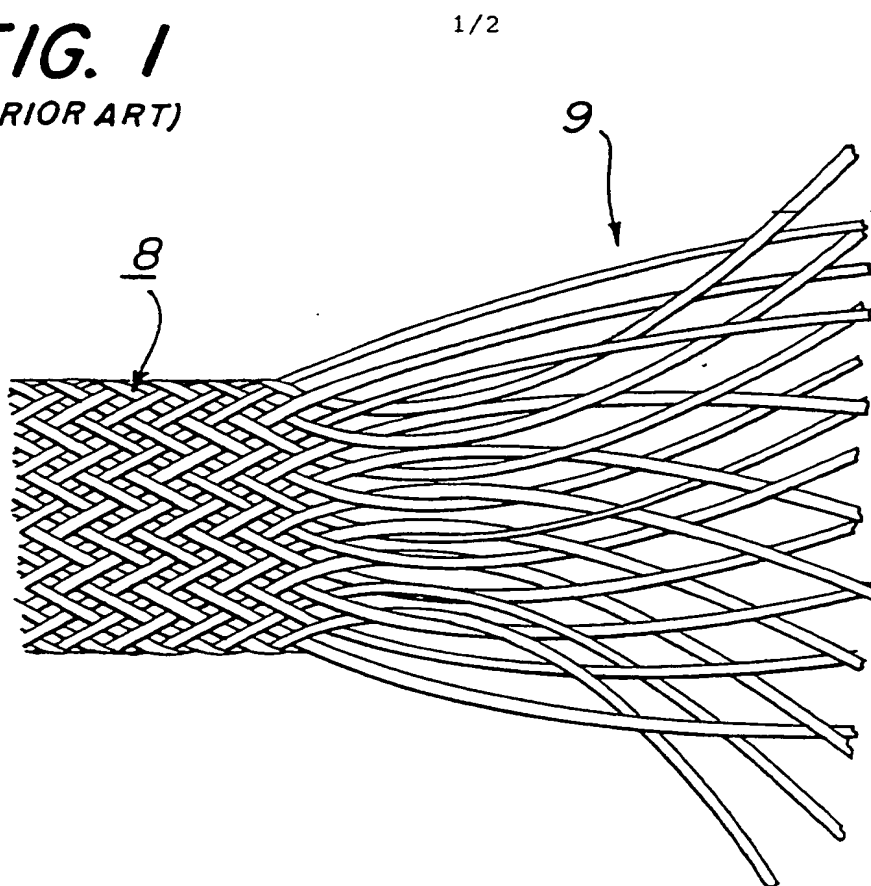
5           15. The method of claim 9, wherein said forming of  
said solid coating comprises coating substantially all  
exposed surfaces of said monofilaments with said material in  
flowable form without filling the openings between said  
monofilaments.

10          16. The method of claim 9, wherein said coating  
extends over the openings between said monofilaments.

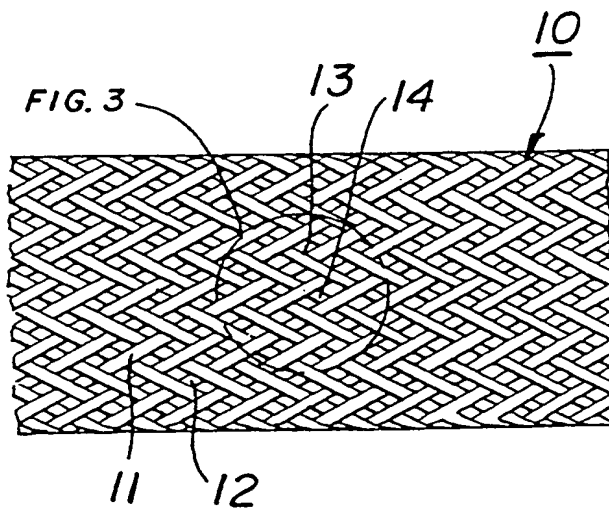
15          17. The method of claim 9, comprising forming said  
solid coating over said monofilaments and the openings  
between them, and thereafter compressing said braided product  
to break open said coating in the regions where it covers  
said openings.

18. The braided product made by any of claims 10-  
17.

**FIG. 1**  
(PRIOR ART)



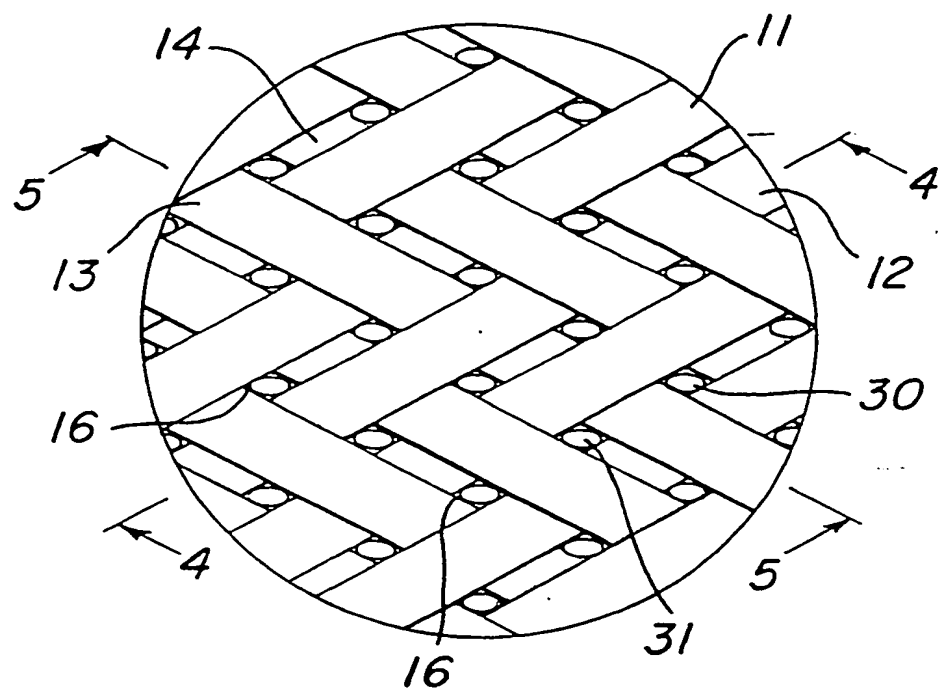
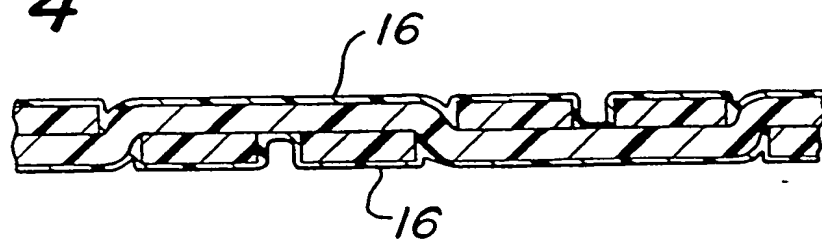
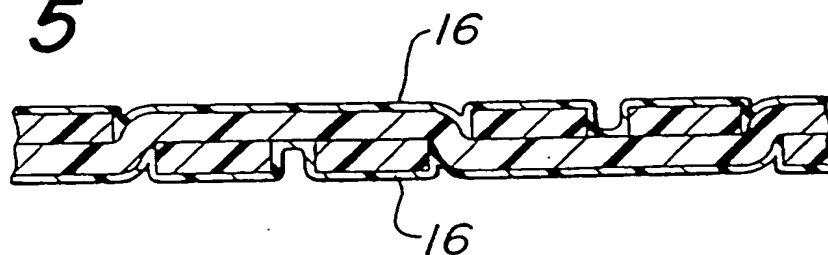
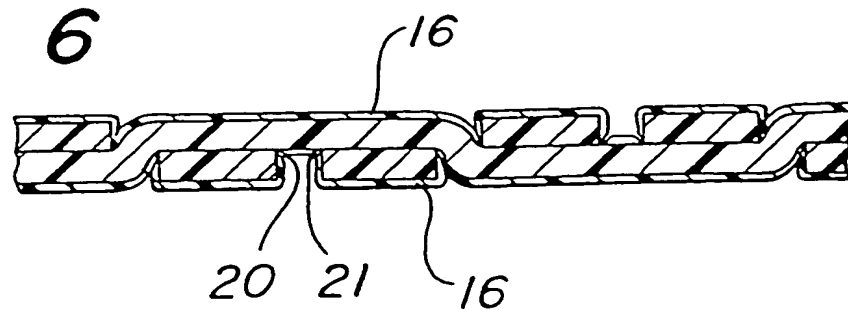
**FIG. 2**



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**FIG. 3**

2/2

**FIG. 4****FIG. 5****FIG. 6**

SUBSTITUTE SHEET

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/01303

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup> According to International Patent Classification (IPC) or to both National Classification and IPC INT. CL(5): D04C 1/02, 1/06 U.S. CL: 87/1, 8, 9																	
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Minimum Documentation Searched <sup>7</sup></div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px;">U.S.</td> <td style="padding: 5px;">87/1, 8, 9 428/37, 222</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup></div>			Classification System	Classification Symbols	U.S.	87/1, 8, 9 428/37, 222											
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U.S.	87/1, 8, 9 428/37, 222																
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category <sup>9</sup></th> <th style="border-bottom: 1px solid black;">Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup></th> <th style="width: 15%; border-bottom: 1px solid black;">Relevant to Claim No. <sup>13</sup></th> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 2,393,530 (HARRIS) 22 JANUARY 1946 see entire disclosure.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-18</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 3,048,078 (KAPLAN) 07 AUGUST 1962 see entire disclosure.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-18</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 2,977,839 (KOCH) 04 APRIL 1961 see entire disclosure.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-18</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 4,754,685 (KITE) 05 JULY 1988 see entire disclosure.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-18</td> </tr> </table>			Category <sup>9</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	Y	US, A, 2,393,530 (HARRIS) 22 JANUARY 1946 see entire disclosure.	1-18	Y	US, A, 3,048,078 (KAPLAN) 07 AUGUST 1962 see entire disclosure.	1-18	Y	US, A, 2,977,839 (KOCH) 04 APRIL 1961 see entire disclosure.	1-18	Y	US, A, 4,754,685 (KITE) 05 JULY 1988 see entire disclosure.	1-18
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<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Δ" document member of the same patent family</p> </div> </div>																	
<b>IV. CERTIFICATION</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;">           Date of the Actual Completion of the International Search   <div style="border: 1px solid black; padding: 2px; display: inline-block;">04 JUNE 1991</div> </td> <td style="width: 50%; padding: 5px;">           Date of Mailing of this International Search Report   <div style="border: 1px solid black; padding: 2px; display: inline-block; font-weight: bold;">24 JUN 1991</div> </td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">           International Searching Authority             ISA/US         </td> <td style="padding: 5px;">           Signature of Authorized Officer             W. J. VanBalen         </td> </tr> </table>			Date of the Actual Completion of the International Search  <div style="border: 1px solid black; padding: 2px; display: inline-block;">04 JUNE 1991</div>	Date of Mailing of this International Search Report  <div style="border: 1px solid black; padding: 2px; display: inline-block; font-weight: bold;">24 JUN 1991</div>	International Searching Authority  ISA/US	Signature of Authorized Officer W. J. VanBalen											
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